BMP #38a - Biofiltration swale (Vegetated swale)

Targeted Pollutants

65% Sediment

15% Phosphorus

Trace metals

Bacteria

Petroleum hydrocarbons

Physical Limits

Drainage area <u>15 ac</u>

Max slope <u>6%</u>

Min bedrock depth <u>3 feet</u>

Min water table <u>2 feet</u>

SCS soil type <u>BCD</u>

Freeze/Thaw <u>fair</u>

Drainage/Flood control <u>yes</u>

DESCRIPTION

Biofiltration swales are vegetated channels with a slope similar to that of standard storm drains channels (less than six percent), but wider and shallower to maximize flow residence time and promote pollutant removal by filtration through the use of properly selected vegetation and settling. Infiltration is not a major component of this best management practice as it is for BMP# 38b, "Bioinfiltration Swales."

Application and Limitations

A vegetated swale is designed to provide runoff treatment of conventional pollutants but are less effective with nutrients. Vegetated swales, when used as a primary treatment measure, should be located "off-line" from the primary conveyance/detention system in order to enhance effectiveness (they can also be made smaller when located off-line). If a biofiltration swale is used to protect a sand filter (BMP #40), then it will be necessary to locate it off-line.

In cases where a vegetated swale is located on-line, it must be sized as both a treatment facility and as a conveyance system to pass the peak hydraulic flows of the 10 and 100-year design storm. To be effective, the depth of the stormwater during treatment must not exceed the height of the grass. Consider using a level spreader (BMP #53) if concentrated flows are too deep for the vegetation.

Biofiltration should be regarded as one possible element of an integrated stormwater management plan for any given site or class of sites. Since flexibility exists in many design features, biofiltration success depends more on proper construction and maintenance than any other factors; effective inspection and enforcement programs should be emphasized to ensure that approved plans are implemented.

Natural drainage courses should be regarded as significant local resources that are generally to be kept in use for stormwater management. Roadside ditches should be regarded as significant potential biofiltration sites; road design standards and ditch maintenance programs should be developed to maximize their usefulness in biofiltration.

Retention/detention pond design requirements should recognize and assess the alternative of installing low-flow biofiltration swales within ponds where sufficient land does not exist for both.

Opportunities to fit biofiltration retroactively to areas already developed should be explored whenever possible. Roadside swales, however, are less feasible increasing numbers of driveways with culverts.

Biofilters should generally not receive construction-site runoff; if they do, presettling of sediments should be provided. Such biofilters should be evaluated for the need to remove sediments and restore vegetation following construction.

Biofilters should be protected from siltation by a presettling basin (BMP #50) when the erosion potential is high; otherwise, presettling is not generally needed for normal operation. However, a series arrangement of a retention/detention pond and biofilter has the ability to offer extra protection to sensitive receiving waters, due to the complementary pollutant removal mechanisms that can operate in the two devices. Equipping both sides of the swale with vegetative buffers or filter strips will also help reduce loading and decrease swale maintenance.

Design Parameters

The design, planning and operation and maintenance details in this fact sheet will ensure that the velocity of the water does not exceed 1.5 feet (0.5 meters) per second along a swale of 200 feet (60 meters) in length during the water quality design storm. As a general rule, the total surface area of the swale should be approximately 1% of the total drainage area. See Appendix G-1 for an example of swale design methodology.

General Criteria

1. For biofiltration, it is important to maximize water contact with vegetation and the soil surface. The soils at the site must support a dense growth of vegetation. Gravelly and coarse sandy soils cannot be used for biofiltration unless the bottom of the swale is lined to prevent infiltration. Also, avoid very heavy clay soils that will not support good vegetative growth.

1. Select vegetation on the basis of pollution control objectives and according to what will best establish and survive in the site conditions. Also, consider whether wildlife habitat development can occur in concert with pollution control. If so, consider the needs of such development in vegetation selection. Check with local Natural Resources Conservation Service personnel for recommended grass species. In general, however, select fine, close-growing, water-resistant grasses. Species with these desirable traits include smooth bromegrass and creeping foxtail. Other good species include wheatgrass (western, tall, or intermediate), tall fescue, or mixtures of big bluestem, little bluestem, switchgrass, Indigo grass, or side-oats grama. Protect these plants from predation during establishment by netting. Selecting different, low-growing ground covers for the swale's side slopes lessens the amount of mowing required.
2. Alternative vegetation may be necessary where some period of soil saturation is expected, where particular pollutant uptake characteristics are desired, or both, select emergent wetland plant species (see BMP #38b). In swales next to roadways where de-icer is regularly used, salt-tolerant species should be used.

1. Establish grasses as follows (all weights are per 1,000 square feet (90 square meters)):

If hydro-seeding - 5 lb. (2.25 kg) seed mix

- 7 lb. (3.2 kg) 10-20-20 (N-P-K) fertilizer*

- 50 lb. (22.7 kg) wood cellulose fiber mulch

If broadcast seeding - 5 lb. (2.25 kg) seed mix

- 7 lb. (3.2 kg) 10-20-20 (N-P-K) fertilizer*

- 70 lb. (31.75 kg) wood cellulose fiber mulch

* Note: this is just an estimate of the amount of fertilizer necessary. Make certain that the proper amount of fertilizer for the soil type is used to avoid over-application.

4. Select a grass height of 6 inches (150 mm) or less and a flow depth of less than 5 inches (130 mm). Grasses over that height tend to flatten down when water is flowing over them, which prevents sedimentation. To attain this height requires regular maintenance.

1. Where grasses are to be cultivated, if possible, select an area where moisture is sufficient to provide water requirements during the dry season, but where the water table is not so high as to cause long periods of soil saturation. Irrigate if moisture is inadequate during summer drought. If saturation will be extended and/or the slope is minimal but grasses are still desired, consider subdrains. Alternatively, consider designing a constructed wetland or wet pond that has substantially longer water residence time than a swale or filter strip.

1. The channel slope should normally be between 2 and 4 percent. A slope of less than 2 percent can be used if underdrains are placed beneath the channel to prevent ponding. For a slope of greater than 4 percent, check dams (see BMP #22) can be used if they are placed in a channel, to slow flows accordingly.

1. If possible, divert runoff (other than necessary irrigation) during the period of vegetation establishment. Sodding is an alternative when rapid establishment must occur. Where runoff diversion is not possible, cover graded and seeded areas with a suitable erosion control slope covering material.

1. Prevent bare areas in biofilters by avoiding gravel, rocks, and hardpan near the surface; fertilizing, watering, and replanting as needed; and ensuring effective drainage. Note: fertilizer must only be used at an application rate and formula which is compatible with plant uptake, and in relation to soil type to help prevent groundwater pollution. For example, high application rates of nitrogenous fertilizer in very permeable soils can result in leaching of nitrate into groundwater.

1. If flow is to be introduced via curb cuts, place pavement slightly above the biofilter elevation. Curb cuts should be at least 12 inches (300 mm) wide to prevent clogging.

1. Attempt to avoid compaction during construction. If compaction occurs, till before planting to restore lost soil infiltration capacity.

Specific Criteria for Biofiltration Swales

1. Design swales for hydraulic capacity and stability according to the method detailed in Appendix D and Appendix G-1. Base the capacity design for biofiltration on the vegetation height equal to the design flow depth and the locally specified water quality design storm of an area. Base the capacity design for flood passage on local agency specifications for flood control.

4. Base the design on a trapezoidal cross-section for ease of construction. A parabolic shape will evolve over time. Make side slopes no steeper than 3:1.
5. Provide a minimum of 200 feet (61 m^2) of swale, using a wide-radius curved path, where land is not adequate for a linear swale (avoid sharp bends to reduce erosion or provide for erosion protection). If a shorter length must be used, increase swale cross-sectional area by an amount proportional to the reduction in length below 200 feet (61 m^2), in order to obtain the same water residence time.

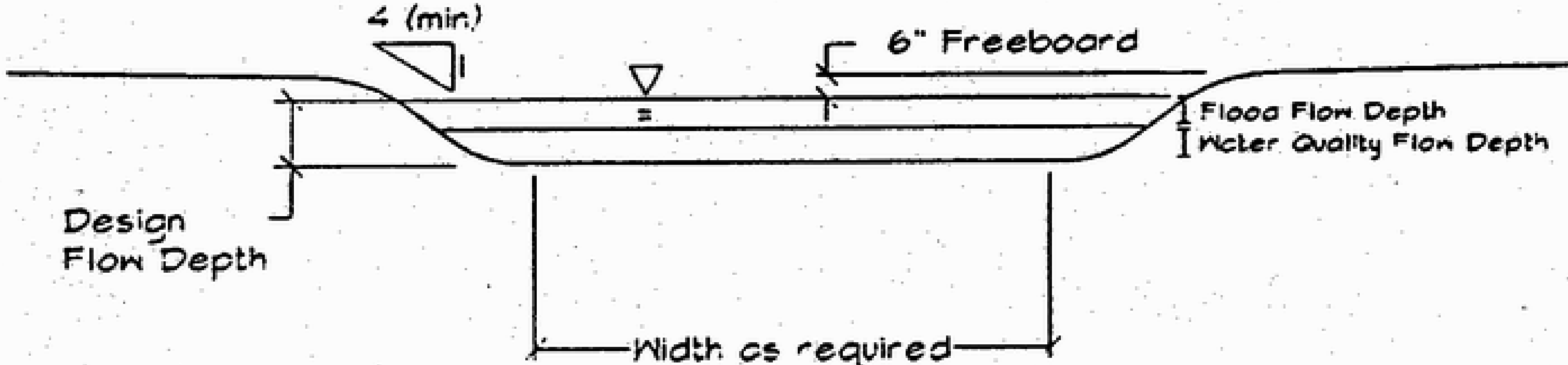
6. Install log or rock check dams approximately every 50 feet (15 meters), if longitudinal slope exceeds 4 percent. Adjust check dam spacing in order not to exceed 4 percent slope within each channel segment between dams.
7. Below the design water depth, install an erosion control blanket, at least 4 inches (100 mm) of topsoil, and the selected biofiltration seed mix. Above the design water line, use an erosion control seed mix with straw mulch or sod.

Construction Guidelines

Example construction guidelines for biofiltration swales are given in Appendix G-1.

Maintenance

1. Groomed biofilters planted in grasses must be mowed regularly during the summer to promote growth and to increase density and pollutant uptake. Be sure not to cut below the design flow (maintenance personnel must be made aware of this requirement). Remove cuttings promptly and dispose in such a way as to ensure that no pollutants enter receiving waters.
2. If the objective is prevention of nutrient transport, mow grasses or cut emergent wetland-type plants to a low height at the end of the growing season. For other pollution control objectives, let the plants stand at a height exceeding the design water depth by at least two inches at the end of the growing season.
3. Remove sediments during summer months when they build up to 6 inches at any spot, cover biofilter vegetation, or otherwise interfere with biofilter operation. Use of equipment like a Ditch Master is strongly recommended over a backhoe or dragline. If the equipment leaves bare spots, reseed them immediately.
4. Inspect biofilters periodically, especially after periods of heavy runoff. Remove sediments, fertilize, and reseed as necessary. Be careful to avoid introducing fertilizer to receiving waters or groundwater.
5. Clean curb cuts when soil and vegetation buildup interferes with flow introduction.
6. Perform special public education for residents near biofilters concerning their purpose and the importance of keeping them free of debris.
7. See that litter is removed in order to keep biofilters attractive in appearance.
8. Base cleaning methods and frequency on an analysis of hydraulic necessity. Use a technique such as the Ditch Master to remove only the amount of sediment necessary to restore needed hydraulic capacity, leaving vegetative plant parts in place to the maximum extent possible.



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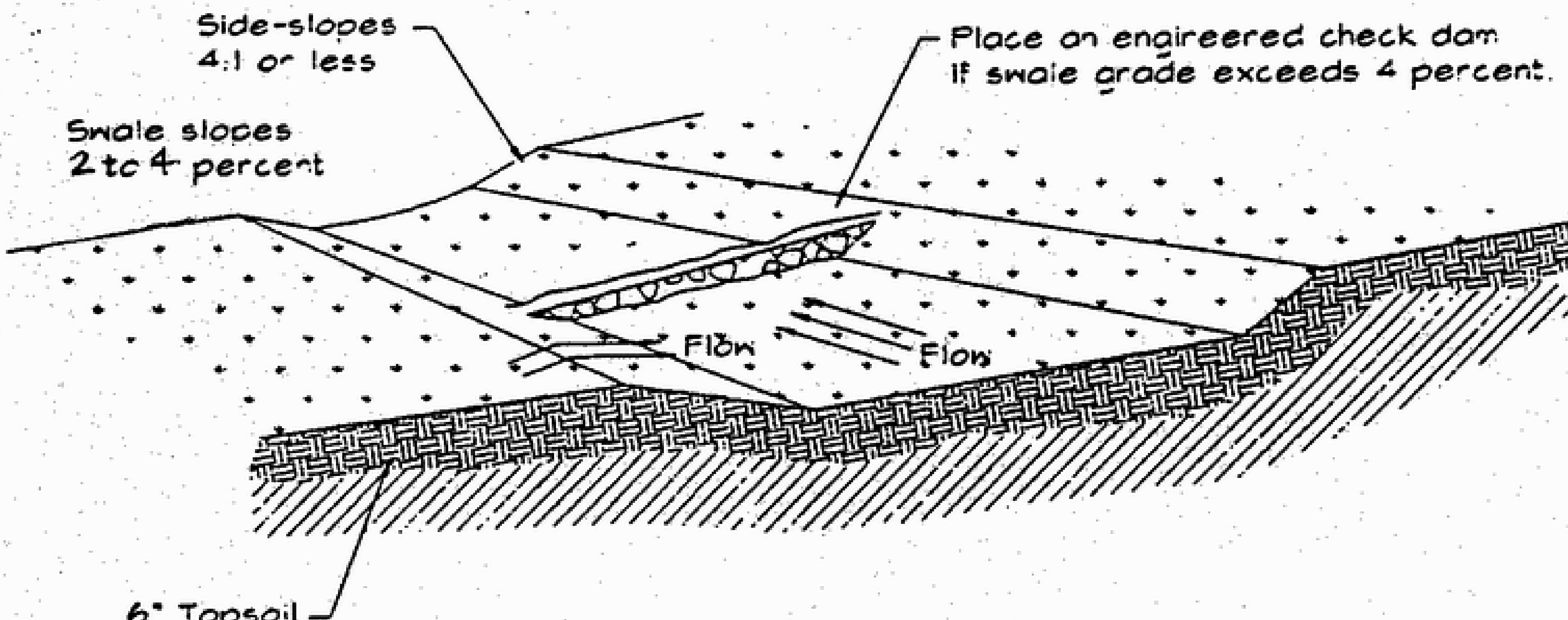

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